DOCUMENT RESUME

ED 227 604 EC 151 034

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TITLE Automatic Memory Processes in Mentally Retarded Persons.
PUB DATE Aug 82
NOTE 20p.; Paper presented at the Annual Meeting of the American Psychological Association (Washington, DC, August 1982).
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Cognitive Processes; *Item Analysis; *Memory; *Mild Mental Retardation; *Moderate Mental Retardation; *Recognition (Psychology); Testing

ABSTRACT

Automatic memory processes were investigated in 10 mild and moderately retarded persons (21 years old) and in 10 chronological age-matched college level and 10 mental age-matched elementary grade control subjects through use of a frequency estimation task. This task required the subjects to view a series of slides, then estimate how many times special target items appeared in the series. Results showed that although both control groups were able to discriminate the frequency of occurrence of most target items, the mentally retarded subjects confused items occurring once with those occurring four times. Also, in most instances the mentally retarded subjects produced less accurate estimates than controls. Findings indicate that mentally retarded persons do possess some basic automatic memory processes, but these processes fail to operate as efficiently as they do in nonretarded populations. (Author/PB)

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Automatic Memory Processes in Mentally Retarded Persons

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Paper presented at the annual meeting of the American Psychological Association, Washington D.C., August 1982.

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Abstract

Automatic memory processes were investigated in 10 mentally retarded persons and in 10 chronological age-matched and mental age-matched control subjects through the use of a frequency estimation task. This task required that subjects view a series of slides and then estimate how many times special target items appeared within the series. Results showed that although both control groups were able to discriminate the frequency of occurrence of most of the target items, the mentally retarded subjects confused items occurring once with those occurring twice, and those occurring three times with those occurring four times. Also, in most instances, the mentally retarded subjects produced estimates which were less accurate than those produced by both the college students and grade school children. These findings indicate that mentally retarded persons do possess some basic automatic memory processes but these processes fail to operate as efficiently as they do in nonretarded populations.

Automatic Memory Processes in Mentally Retarded Persons

Hasher and Zacks (1979) have proposed a framework which attempts to describe the various memory processes that people have available by ordering these processes along a continuum of effort or capacity ranging from automatic to effortful. Automatic processes are those which drain the least amount of energy from a person's limited capacity attentional mechanism. They are thought to be responsible for the encoding of fundamental aspects of the flow of information; especially spatial, temporal, and frequency of occurrence information. Automatic processes occur without intention, do not benefit from practice, and show limited developmental trends. These are processes for which humans are presumably genetically prepared. Automatic processes are completed at an early age, largely as a function of maturation, and are supposedly the processes which mediate much of the early learning of the human organism (Zacks, Hasher, & Sanft, in press).

Effortful processes drain the largest amount of energy from a person's limited capacity attentional mechanism. These processes are engaged when cognitive strategies are employed to assist in the encoding of information into memory. Examples of these strategies include the use of rehearsal, organization, and the use of elaborative and mnemonic devices. Effortful processes require intention to occur and are enhanced by practice. They can be considered the more advanced of the memory phenomena. Young children seldom employ effortful processes, but systematic increases in application and proficiency are seen with age (Flavell & Wellman, 1977; Hagen, Jongeward & Kail, 1975; Kail, 1979; Moely, 1977).

Research has shown that mentally retarded persons perform more poorly than age-matched nonretarded subjects in a variety of memory situations (Campione

& Brown, 1977). This poor performance occurs primarily on those tasks requiring the use of effortful processing skills. Mentally retarded persons do not rehearse information to be recalled. Their response patterns show no evidence of a primacy effect (Ellis, 1970); they do not benefit from increasing the temporal spacing of consecutive items during presentation (Ellis, 1970); and when studying items at their own pace, mentally retarded persons produce pause-patterns that show no indication of strategy use (Belmont & Butterfield, 1971). Mentally retarded persons also do not spontaneously organize items into categories to assist recall (Goulet, 1968; Jensen & Frederiksen, 1973); nor do they spontaneously engage in the use of elaborative devices (Borkowski & Wanshura, 1974). Furthermore, when mentally retarded subjects are trained to use memory strategies, the training is seldom retained, and shows little generalization to new task situations (Brown, Campione, & Murphy, 1976; Brown, Campione, Bray, & Wilcox, 1973; Butterfield, Wambold, & Belmont, 1973; Gerjuoy & Spitz, 1966; Herriot, Green, & McConkey, 1973).

Although the effortful memory processing skills of mentally retarded persons have been extensively investigated, the automatic processing area is virgin territory. Even though effortful processes are disrupted in this population, mentally retarded persons still absorb information from the environment and store it in memory. Since automatic processes are assumed to be a prewired part of the organism, there is reason to believe that automatic processes are fully operative in the mentally retarded population. This study was performed to investigate the extent of automatic processing skills in mentally retarded persons through the use of a frequency estimation task.

A frequency estimation task was chosen because evidence suggests that the encoding of frequency of occurrence information is automatic. College students,

elementary school children, kindergarten children, learning disabled children, middle-aged persons, and the elderly have all been found to be able to discriminate the frequency of occurrence of events (Attig & Hasher, 1980; Hasher & Chromiak, 1977; Hasher & Zacks, 1979; Johnson, Raye, Hasher, & Chromiak, 1979; Kausler & Puckett, 1980; Goldstein, Stein, Golding, & Hasher, 1981). Frequency discrimination occurs without intention and shows no improvement with the addition of the decision to remember or with task-specific practice (Hasher & Chromiak, 1977; Howell, 1977). Non-laboratory tests have revealed that people do naturally encode occurrence rates for events such as words, letters, pairs of letters, professions, and morbidity rates (Attneave, 1953; Lichtenstein, Slovic, Fischhoff, Layman, & Combs, 1978; Shapiro, 1969; Underwood, 1971). In addition, it has been argued that frequency information is critical for the execution of a variety of important cognitive processes, e.g., reading, decision making, and remembering past events (Haber, 1978; Hasher & Zacks, 1979). Since the processing of frequency of occurrence information seems to be such a basic and natural process, this investigation attempted to assess the performance of mentally retarded persons in this area.

Method

Subjects

Thirty subjects participated in this study. Ten of the subjects were mentally retarded persons attending the Gertrude A. Barber Center in Erie, PA. These subjects exhibited I.Q. scores falling into the mild and moderate categories with a mean I.Q. of 52.5. Ten of the subjects were college students matched on chronological age and sex to the mentally retarded subjects. The remaining 10 subjects were grade school children matched on mental age and sex to the mentally retarded subjects. Since performance differences on cognitive

tasks are expected to exist between mentally retarded persons and their chronological age-matched nonretarded peers, the grade school children were used in order to control for discrepancies in cognitive level. The chronological ages of the mentally retarded, college, and grade school subjects were 21.0 years, 21.4 years, and 7.75 years, respectively.

Materials

The materials used in this study were 50 color slides of familiar objects (e.g., hat, flowers, ring, lamb, etc.). The slides were used to fill a presentation list that was 70 slots in length. Ten items were buffer items. These slides appeared only once and they appeared in the first five and last five slots of the list. Twenty items served as filler items. These slides were scattered throughout the middle 60 slots of the list. Each filler item appeared only once and there were five such items in each quarter of the list.

The remaining 20 items served as target items in the experiment. Of these target items, four items appeared once, twice, three times, and four times in the list, so that four frequency levels were represented. One item from each frequency level occurred in each quarter of the list. Items were assigned randomly within each quarter with the restriction that no repeated item ever follow itself. The remaining four target items were used to test the zero presented frequency level. These items were not shown to the subject until the test list was presented. The test list included all 20 target items and was shown immediately after the presentation list. The items in the test list were randomly ordered.

Procedure

Before viewing the presentation list, each person was told that he or she would see a series of pictures on a small screen. The person was asked

to say the name of the item in the picture as soon as it appeared. The person was asked to pay close attention to each item because after all of the slides were seen, some questions would be asked about them. Subjects were not given information about the multiple presentation of some slides, or about the true nature of the test task. All presentation slides were shown for 3 seconds with a .8 sec. slide change interval. All subjects assigned appropriate names to the items depicted and used the same name to label each repetition of the item.

The test list instructions were given immediately after the last slide was presented. Each person was told that some of the pictures would be presented again along with some that had not been presented. If the item was old, the person was asked to tell the experimenter how many times he or she saw the item in the first list. If the item was new, the experimenter told the person to say so. Each test item was shown for 6 seconds with a .8 sec. slide change time.

Results

A 3(population) X 5(frequency level) repeated measures analysis of variance was performed on the mean frequency estimates for items presented at each of the frequency levels tested (0, 1, 2, 3, and 4). The analysis revealed that frequency level was a significant factor, $F(4, 108) = 89.89$, $p < .001$. As Table 1 shows, in all but one instance, frequency estimates increased with increases in the true frequency of occurrence of items. The only apparent inversion occurred for grade school children. These children assigned higher estimates to items presented two times versus those presented three times.

Although no significant main effect could be attributed to population, the population by frequency level interaction was significant, $F(8, 108) = 3.48$ $p < .01$. This interaction was explained by taking a look at the ability

of each population to reliably discriminate those items occurring at one frequency level from those occurring at the next. Individual Neuman-Keuls analyses were performed on each population's mean frequency estimates for this purpose.

The Neuman-Keuls analysis performed on the college students' estimates revealed that college students could reliably distinguish ($p < .01$) between all items presented at the different frequencies except for those items presented two versus three times. College students tended to assign inflated estimates to those items which occurred twice in the presentation list (see Table 1), making their estimates comparable to those assigned to the items appearing three times.

The Neuman-Keuls analysis performed on the grade school children revealed a pattern identical to that of the college students. The children could reliably distinguish ($p < .01$) between items occurring at consecutive frequencies except for the case of 2 versus 3. The grade school children assigned even higher estimates than the college students to those items presented twice. This inflated estimate not only resulted in its being comparable to the mean estimate assigned to the items appearing three times, but also resulted in the inversion found in the grade school children's estimates.

The Neuman-Keuls analysis performed on the mean frequency estimates of the mentally retarded subjects resulted in a performance profile much different from the profiles exhibited by the other two groups. This produced the significant age by frequency level interaction. In contrast to the college students and grade school children, mentally retarded persons could discriminate those items presented twice from those presented three times ($p < .05$), but they could not distinguish items occurring once from those occurring twice, or those occurring three times from those occurring four times. Figure 1 shows that mentally

retarded subjects tended to overestimate the frequency of occurrence of items presented one time, pushing their estimates close to those given for frequency 2. They also tended to underestimate the frequency of occurrence of items presented four times, pushing their estimates close to those given for frequency 3.

In order to assess each population's accuracy in estimating the frequency of occurrence of items presented at each frequency level, the unsigned deviation of each estimate from the true frequency of occurrence was computed for each item. These figures, in turn, were entered into a 3(population) X 5(frequency level) repeated measures analysis of variance. The results of this analysis indicated that population was a significant factor, $F(2,27) = 7.14$, $p < .01$. The mentally retarded subjects were much less accurate (had higher deviation scores) than the college students at each of the frequency levels tested. They were also less accurate than the grade school children at all but frequencies 2 and 3 (see Table 2). The college students were more accurate (had lower deviation scores) than the grade school children for all frequencies except 0 and 1.

Although frequency level was also a significant factor, $F(4,108) = 14.83$, $p < .001$, it was hard to interpret because of the significant population by frequency level interaction, $F(8,108) = 2.12$, $p < .05$. An inspection of Figure 2 does indicate that the unsigned deviation scores show an overall increase with increases in the frequency of occurrence of items, but the relative standing of each population varies considerably from frequency to frequency.

The standard deviation scores show that the mentally retarded subjects gave more variable frequency estimates at each of the frequencies tested (see Table 1).

Discussion

The results of this study reveal that college students, grade school children and mentally retarded persons all encode frequency of occurrence information. However, college students and grade school children are better at making fine discriminations between events occurring at consecutive frequencies. Although the college students and grade school children did experience a problem with distinguishing items presented two times from those presented three times, this was probably due to some unknown characteristics of the items presented at frequency 2 (Underwood & Freund, 1970). The construction of additional presentation lists by rotating each item through each of the frequency levels tested would have reduced this effect.

Since mentally retarded persons could discriminate between items presented at all frequencies except one versus two and three versus four, it may be concluded that the mentally retarded do possess the ability to encode frequency of occurrence information, but that the process is inefficient. The overestimation of the frequency of occurrence of items presented one time, and the underestimation of the frequency of occurrence of items presented four times leads to the belief that although mentally retarded persons process frequency rates, their number concept may be immature. As a result, they assign "ballpark" figures rather than more accurate numbers to the encoded frequency. Although all of the mentally retarded subjects were asked if they could count to ten, they were not drilled on their ability to match the words with concrete items in the environment. A test of their ability to sort items into number categories could have been used to control for this problem.

The finding that mentally retarded persons can process frequency of occurrence information indicates that they do possess at least one skill which falls

into the automatic memory category. However, previous work shows that mentally retarded persons also perform well on recognition memory tasks (Brown, 1972; Brown, 1973b) and on tasks requiring judgments of relative recency (Brown, 1973a; Brown, Campione, & Gilliard, 1974). According to Hasher and Zacks (1979) these tasks also require the use of automatic memory functions. Since the ability to automatically encode information for future retrieval is an integral part of cognitive functioning, further attempts to investigate the extent and precision of automatic memory processes in the mentally retarded is warranted. The results of these investigations could lead to the creation of new theories of learning and more efficient remedial techniques.

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Table 1

Mean Frequency Estimates for College Students, Grade School Children, and Mentally Retarded Persons.

Population	Frequency Level 0	1	2	3	4
College Students	.03	1.10	2.70	3.05	3.93
n = 10	(.08)[a]	(.17)	(.82)	(.71)	(1.31)
Grade Schoolers	.00	1.18	3.45	3.30	4.48
n = 10	(.00)	(.41)	(1.10)	(.99)	(1.06)
Mentally Retarded	.60	2.38	2.58	3.15	3.40
n = 10	(.87)	(1.64)	(1.40)	(1.41)	(1.83)

Note. Four items were presented to each subject at each frequency level.

[a] Standard deviations are in parentheses.

Table 2

Mean Unsigned Deviation Scores for College Students, School Children, and Mentally Retarded Persons

Population	Frequency Level 0	1	2	3	4
College Students	.03	.10	.80	.75	.98
n = 10	(.08)[a]	(.17)	(.77)	(.42)	(.99)
Grade Schoolers	.00	.18	1.45	1.30	1.33
n = 10	(.00)	(.41)	(1.10)	(.67)	(.87)
Mentally Retarded	.60	1.58	1.38	1.30	1.80
n = 10	(.87)	(1.43)	(.65)	(.76)	(.90)

Note. Four items were presented to each subject at each frequency level.

[a] Standard deviations are in parentheses.

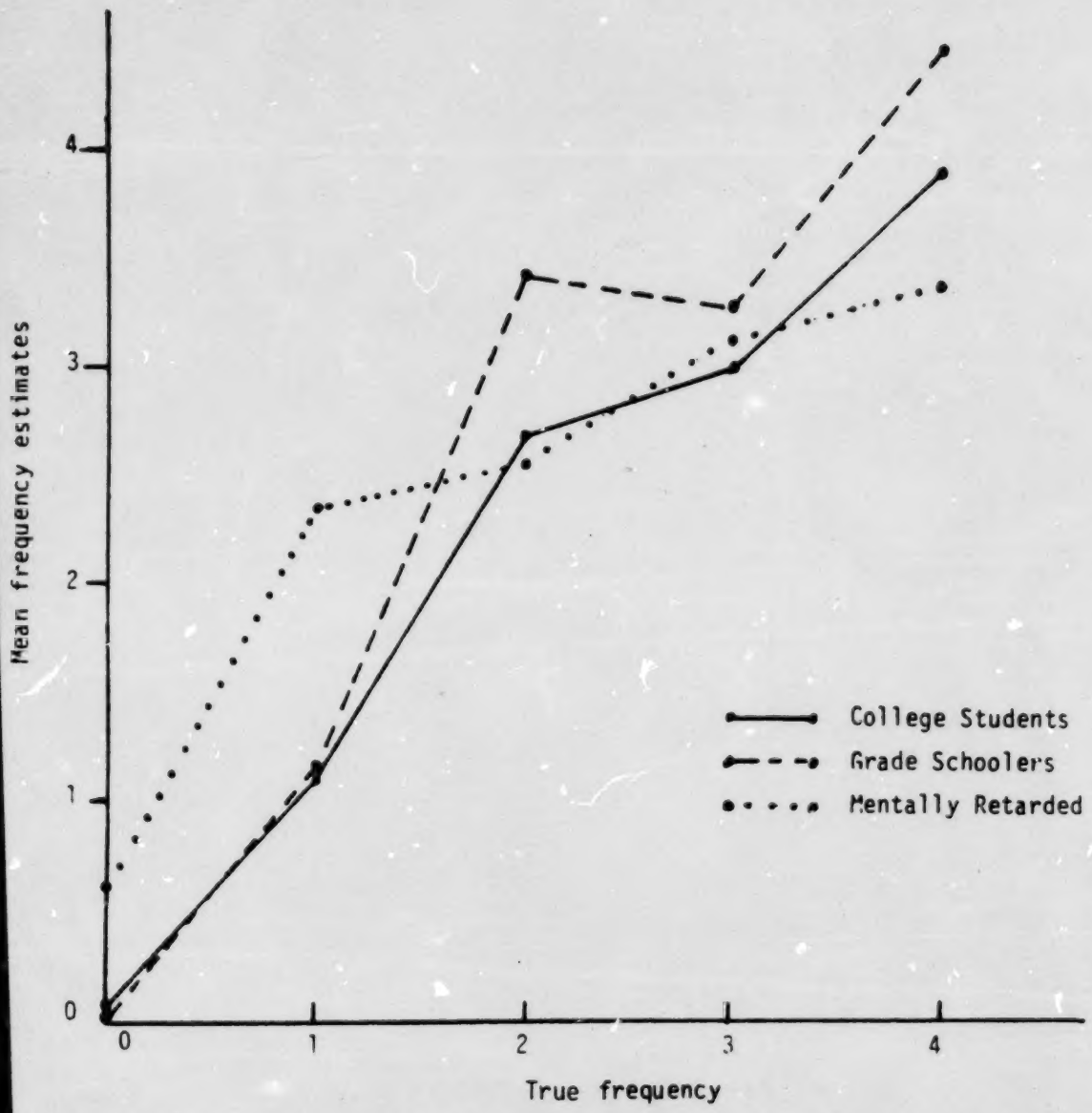

Figure 1. Mean frequency estimates for college students, grade school children, and mentally retarded persons as a function of the actual frequency of occurrence of items.

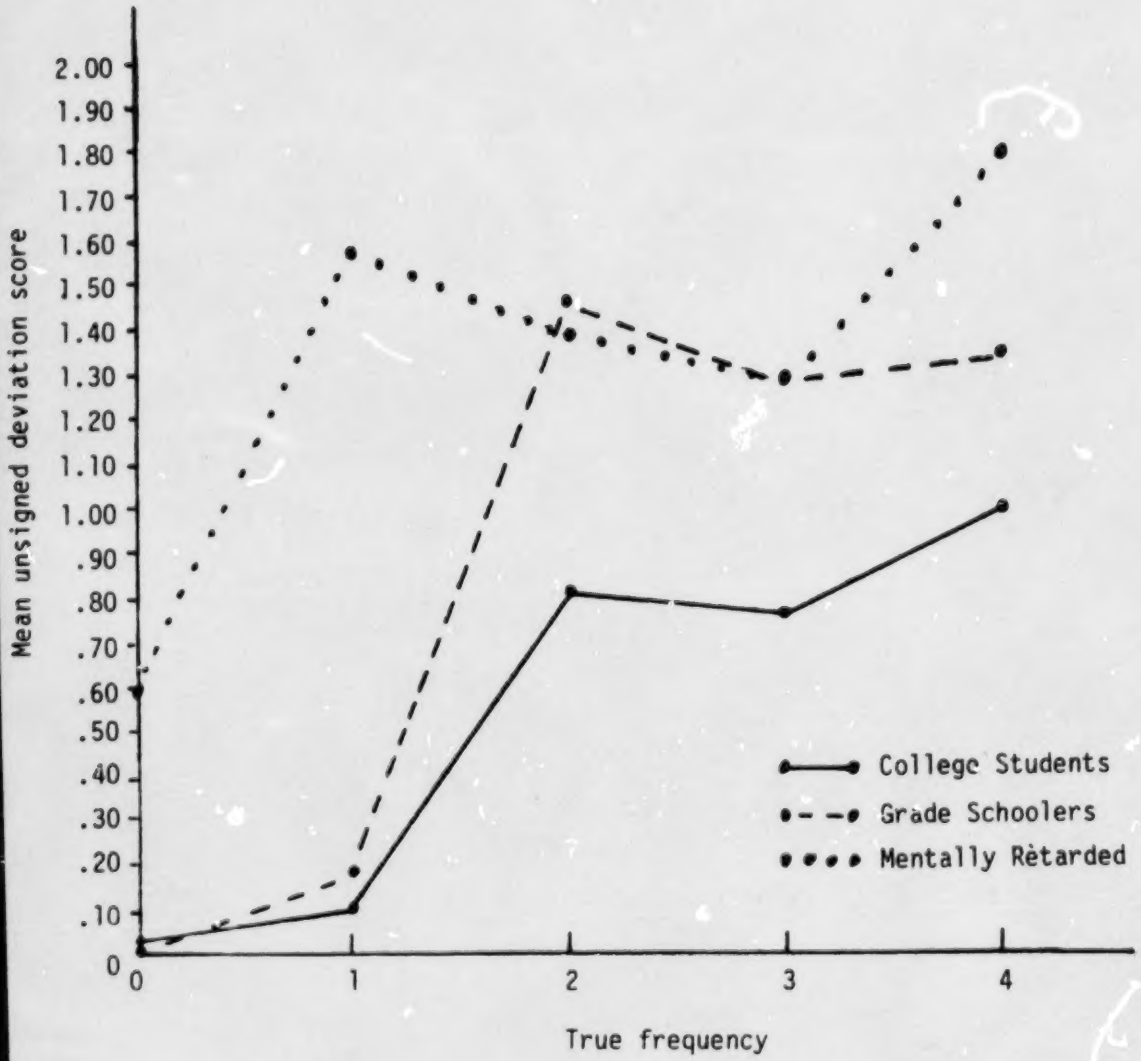

Figure 2. Mean unsigned deviation scores for college students, grade school children, and mentally retarded persons as a function of the true frequency of occurrence of items.